ELECTRICAL—TH!NK VEHICLES—BATTERY RECOVERY/BALANCING AND BATTERY RANGE TIPS	Article No. 03-8-6

THINK: 2002 TH!NK NEIGHBOR

ISSUE

Some 2002 Th!nk Neighbor vehicles may exhibit a no start condition, inability to charge, or reduced mileage range. This may be due to a deeply discharged battery pack, failed battery modules, or an unbalanced battery pack.

ACTION

Diagnose the health of battery pack and individual battery modules to determine repair action. Follow Flow Chart 1 (Figure 6) for direction. This TSB outlines procedures for evaluating battery health, replacing individual battery modules, battery recovery, and balancing battery modules to maximize pack performance.

SERVICE INFORMATION

Battery recovery and "top of charge" (TOC) battery pack balancing is the main subject matter of this article. It must be noted that the DPI smart chargers used for recovery and battery pack balancing will not initiate charge unless the battery is above 3Vdc.

NOTE

THE NEW VEHICLE LIMITED WARRANTY DOES NOT COVER DAMAGE CAUSED BY FAILURE TO MAINTAIN THE VEHICLE OR IMPROPERLY MAINTAINING THE VEHICLE. IF THE BATTERIES ARE REPLACED UNDER WARRANTY, ALL CAUSAL PARTS OF THE ASSOCIATED DAMAGE TO THE BATTERIES MUST BE RETURNED PER WARRANTY RETURN TAG INSTRUCTIONS AND MAY BE ANALYZED FOR FAILURE. IN THE ABSENCE OF A CASUAL PART, WHICH HAS CAUSED THE BATTERIES TO DISCHARGE BELOW MINIMUM VOLTAGE, IT IS PRESUMED THAT THE BATTERIES WERE NOT MAINTAINED CORRECTLY AND ALLOWED TO DISCHARGE. BATTERY RECOVERY IS AT THE CUSTOMERS DISCRETION AND IS NOT COVERED UNDER WARRANTY.

If the battery pack voltage is from 68.3V to 80V, the vehicle should enable. If it does not enable, follow the TH!NK Neighbor no enable troubleshooting flow chart found in TSB 02-25-9. If the battery pack is greater than 20Vdc and less than 68.3Vdc, the charger should charge the batteries. Refer to the charging section of this TSB for direction. If the pack is under 20V, the on-board charger will not charge the pack and the battery modules must be individually charged. Refer to the battery pack balancing & recovery section.

If the vehicle mileage range is drastically reduced from the normal range experienced by the customer, the pack must be checked referencing the vehicle range concern section. It is possible the batteries have been discharged to a very low level and have become unbalanced, if so, refer to the battery pack balancing section.

DIAGNOSTICS

Follow Flow Chart 1 (Figure 6) to determine proper repair procedures.

Use Figure 1 to assess the state of charge of the battery pack. Verify that the charger and charging receptacle are functioning properly, by measuring pack voltage as shown in Figure 2 while the vehicle is on charge. With the vehicle on charge, pack voltage should rise above the static pack voltage. If there is no rise in pack voltage after 15 minutes of charging, the charger, charging circuit, charger cord, or charging inlet receptacle is malfunctioning. If pack voltage is less than 20 volts the batteries must be individually charged with DPI chargers specified within this TSB. DPI smart chargers will not activate if the battery is below 3Vdc.

Batteries

The battery pack consists of 6, individual 12-volt modules. Battery modules are defined as the individual 12-volt batteries which, when connected in series, make up the 72-volt battery pack. The Th!nk Neighbor uses lead-acid deep cycle batteries, which are different from typical automotive starting batteries. Only Ford Motor Company recommended batteries should be used for replacements. Use of any unauthorized battery may negatively affect the battery range, life, and durability and will not be covered under warranty.

NOTE

WHEN THE VEHICLE IS GOING TO BE STORED FOR 14 DAYS OR MORE, THE SERVICE DISCONNECT SWITCH SHOULD BE TURNED OFF. PROPER CHARGING OF THE TH!NK NEIGHBOR IS THE RESPONSIBILITY OF THE CUSTOMER OR THE DEALERSHIP WHILE IN SERVICE. THE VEHICLE SHOULD BE PLUGGED IN AT ALL TIMES WHEN IT IS NOT BEING USED OR WHILE IT WAITS FOR SERVICE AND UNTIL RETURNED TO THE CUSTOMER.

Battery Care

The Th!nk Neighbor is equipped with a "Service Disconnect Switch" (SDS) to help preserve battery life. The switch is located under the seats, to the rear of the parking brake. For vehicles produced after 6/24/02, the switch is located directly under the drivers seat. Beginning with a fully charged vehicle, the battery pack will remain charged approximately 14 days with the SDS "ON", and approximately six months with the SDS "OFF". The Neighbor is shipped with the switch in the "OFF" position to preserve battery pack charge. If a vehicle will not be used for more than 14 days, fully charge the vehicle (12 hours of charging), turn the ignition to the "OFF" position, and turn the service disconnect switch to the "OFF" position. The vehicle can be left unplugged with a fully charged battery and the service disconnect switch turned "OFF" for up to 6 months. It is recommended, if possible, to charge the vehicle once a month for 12 hours during storage.

Always store the vehicle with the service disconnect switch "OFF" at the dealership. You must charge the battery pack every 30 days (per the Warranty Policy and Procedure Manual), even if the service disconnect switch is "OFF", while the vehicle is at the dealership.

NOTE

WHILE AT THE DEALERSHIP FOR SERVICE IT IS THE DEALERSHIPS RESPONSIBILITY TO MAINTAIN THE BATTERY PACK CHARGE LEVEL. IT IS RECOMMENDED TO CHECK AND DOCUMENT FOR LATER VERIFICATION THE BATTERY PACK VOLTAGE WHEN A VEHICLE IS BROUGHT IN FOR SERVICE AND MONTHLY WHILE IN THE DEALERSHIPS POSSESSION.

Check For Voltage From The Battery Pack To Chassis

1. Check for pack voltage in the chassis by setting the DVOM to read DC volts.
2. Touch the NEGATIVE lead of the DVOM to the battery pack NEGATIVE terminal on battery number one.
3. Touch the POSITIVE lead of the DVOM to an unpainted section of the chassis.
4. Check for voltage.

If voltage is found, the battery pack short to chassis must be repaired before any further steps are taken.

Check Each Battery For Polarity

1. Use a DVOM to check battery polarity on each individual module.
2. Set the DVOM to DC voltage.
3. Touch the POSITIVE lead of the DVOM to the POSITIVE terminal of the battery.
4. Touch the NEGATIVE lead of the DVOM to the NEGATIVE terminal of the battery.
5. Repeat for all batteries.

If the polarity is reversed and negative voltage reading is found, then remove and replace the battery with a Ford recommended replacement battery.

NOTE

WHEN REPLACING INDIVIDUAL MODULES IN THE BATTERY PACK, ALL THE MODULES INCLUDING THE NEW BATTERY MUST BE BALANCED TO "TOP OF CHARGE" WITH THE SMART DPI CHARGERS.

NOTE
DO NOT USE A ROTUNDA OR ANY OTHER BATTERY CHARGER WHICH CHARGES AT GREATER THAN 14.1 VOLTS. THIS MAY DAMAGE THE TH!NK NEIGHBOR BATTERIES.

Battery Health Testing Using The Micro 490 To Test Th!nk Neighbor Battery Modules

Do not use cold cranking amps or open circuit voltage tests to determine if a battery module in the pack is defective. These tests are not accurate. The only accurate method of determining which module is defective is to use the Micro 490 Battery Tester supplied by Rotunda, or the DPI charger. The battery must be charged before the Micro 490 will accurately test the battery.

Battery Testing With The Micro 490

There is a draw on the batteries even with the SDS "OFF". There is a 1 mA draw from the charger (the charger is hot at all times) and this will negatively affect the Micro 490. The Micro 490 will only provide accurate results when there is no draw on the battery. To correctly use the Micro 490 battery tester the pack must be separated into individual battery modules.

Follow this procedure to test individual batteries:

1. Remove the front seat bottom cushion.
2. Turn the SDS (Service Disconnect Switch) "OFF".
3. Remove the front stanchion cover.
4. Follow the power down procedure.

WARNING
THE BATTERY PACK CONTAINS HIGH-VOLTAGE COMPONENTS AND WIRING. HIGH-VOLTAGE INSULATED SAFETY GLOVES AND FACE SHIELD MUST BE WORN WHEN PERFORMING THE FOLLOWING STEPS. FAILURE TO FOLLOW THIS WARNING MAY RESULT IN SEVERE PERSONAL INJURY OR DEATH.

WARNING
THE BATTERY PACK ASSEMBLY CAN DELIVER IN EXCESS OF 72 VOLTS OF DC POWER. IMPROPER HANDLING OF THE BATTERY PACK CAN RESULT IN INJURY OR FATALITY. ONLY AUTHORIZED PERSONNEL TRAINED TO WORK WITH BATTERY PACK COMPONENTS ARE PERMITTED TO HANDLE THE BATTERIES.

WARNING
MAKE SURE THE VEHICLE IS NOT BEING CHARGED.

a. Connect the capacitor discharge tool.

To discharge the motor controller:

b. Touch the NEGATIVE probe of the DVOM to the B- (battery negative, labeled "Batt 1 NEG").

c. Touch POSITIVE probe of the DVOM to the load side of the 10-amp fuse for the motor controller circuit. This will be the spade connector closest to the front of the fuse holder and it is labeled "GAUGE/MTR-CNTR".

d. The DVOM will display any voltage present. Repeat steps 4b and 4c if DVOM reads more than 0 volts.

To discharge the DC/DC converter 1 (standard) or DC/DC 2 (optional):

e. Touch the NEGATIVE probe of the DVOM to the B- (battery negative, labeled "BATT1 NEG").

f. Touch the positive probe of the DVOM to the load side of the 10-amp fuse for the DC/DC circuit. This will be the spade connector closest to the front of the fuse holder and it is labeled "DC/DC".

g. The DVOM will display any voltage present. Repeat steps 4b and 4c of DVOM reads more than 0 volts.

5. Disconnect all battery cables from the threaded terminals.
6. Connect the Micro 490 to the lead doughnut of the battery terminal. The battery must be charged for the Micro 490 to properly test the battery. Do not test connecting the tester clamp to the stainless steel stud or nut.

NOTE
CLAMP ON EITHER THE LEAD DONUT AT THE BASE OF THE THREADED STUD, OR THE BATTERY CABLE EYELET. DO NOT CLAMP ON THE THREADED STUD, OR THE NUT. THE STUD AND NUT ARE NOT RELIABLE CONDUCTORS, AND TEST RESULTS WILL NOT BE ACCURATE.

7. If a bad battery is found, record the indictment codes on the repair order, as they are required for payment of the warranty claim.

8. If replacing an individual battery (module) is required, the pack must be balanced to "top of charge". Refer to the battery balancing section of the TSB for instructions.

BATTERY PACK BALANCING AND RECOVERY

The DPI smart charger must be used to balance and recover battery packs. The DPI smart charger is an advanced full-featured charger. It has an intelligent microprocessor that performs scientific calculations (also called an "Algorithm") to determine the batteries state of charge. It monitors the battery terminal's voltage and charge current change with respect to time, where other chargers simply monitor a battery's terminal voltage against an internally preset voltage level and then always incorrectly displays a "CHARGED" indication once the battery terminal voltage has reached a certain level, which occurs when your battery's state of charge is only at approximately 40% to 75%.

DPI Contact Information:

Diversified Power International 414-Century Court Piney Flats, TN 37686 USA (423) 538-9002

NOTE
BATTERY PACK RANGE MAY DECREASE INITIALLY AFTER REPLACING, BALANCING, OR RECOVERING BATTERIES, HOWEVER THE RANGE SHOULD INCREASE AFTER APPROXIMATELY 4-6 FULL BATTERY PACK DISCHARGES AND CHARGES.

Procedure For Smart DPI Charging

All the batteries must be balanced by fully charging each battery to "TOC" even when replacing individual modules. If all batteries are not balanced at "TOC", the pack will have diminished range and may fail within several months. Follow the procedure to balance the battery pack.

1. Remove the front seat bottom cushion.

2. Turn SDS (Service Disconnect Switch) "OFF".

3. Check pack voltage, if pack voltage is under 20 volts continue to Step 4. If the voltage is over 20 volts charge the vehicle for 12 hours with the "on board charger". Refer to the charger troubleshooting section of the Service Manual if the pack voltage does not rise within 15 minutes after the charger is plugged in.

NOTE
IT IS NOT NECESSARY TO REMOVE THE H-FRAME OR PARK BRAKE LEVER AND CABLE.

4. Remove front seats.

5. Remove the front stanchion cover.

6. Follow the power down procedure.

WARNING
THE BATTERY PACK CONTAINS HIGH-VOLTAGE COMPONENTS AND WIRING. HIGH-VOLTAGE INSULATED SAFETY GLOVES AND FACE SHIELD MUST BE WORN WHEN PERFORMING THE FOLLOWING STEPS. FAILURE TO FOLLOW THIS WARNING MAY RESULT IN SEVERE PERSONAL INJURY OR DEATH.

WARNING
THE BATTERY PACK ASSEMBLY CAN DELIVER IN EXCESS OF 72 VOLTS OF DC POWER. IMPROPER HANDLING OF THE BATTERY PACK CAN RESULT IN INJURY OR FATALITY. ONLY AUTHORIZED PERSONNEL TRAINED TO WORK WITH BATTERY PACK COMPONENTS ARE PERMITTED TO HANDLE THE BATTERIES.

WARNING
MAKE SURE THE VEHICLE IS NOT BEING CHARGED.

a. Connect the capacitor discharge tool.

To discharge the motor controller:

b. Touch the NEGATIVE probe of the DVOM to the B- (battery negative, labeled "Batt 1 NEG").

c. Touch POSITIVE probe of the DVOM to the load side of the 10-amp fuse for the motor controller circuit. This will be the spade connector closest to the front of the fuse holder and it is labeled "GAUGE/MTR-CNTR".

d. The DVOM will display any voltage present. Repeat Steps 6b and 6c if DVOM reads more than 0 volts.

To discharge the DC/DC converter 1 (standard) or DC/DC 2 (optional):

e. Touch the NEGATIVE probe of the DVOM to the B- (battery negative, labeled "BATT1 NEG").

f. Touch the POSITIVE probe of the DVOM to the load side of the 10-amp fuse for the DC/DC circuit. This will be the spade connector closest to the front of the fuse holder and it is labeled "DC/DC".

g. The DVOM will display any voltage present. Repeat Steps 6f and 6g if DVOM reads more than 0 volts.

7. Disconnect all battery cables from the threaded terminals.

8. Check each battery with a voltmeter for reversed polarity, if reversed polarity is found scrap battery immediately.

NOTE
DO NOT CHARGE ANY BATTERIES THAT HAVE REVERSED POLARITY.

9. Check each individually battery module voltage, if battery voltage varies more than .2V, the batteries must be balanced to the "TOC" with the Smart DPI chargers.

NOTE
BATTERY MODULE VOLTAGE MUST BE A LEAST 3VDC FOR THE SMART DPI CHARGER TO INITIATE CHARGE.

10. Connect the DPI smart battery charger to each battery's lead doughnut then plug charger in, follow charging instructions from the DPI charger manufacture.

11. Allow the charger to run the diagnostics.

12. If the light stays red the battery is either at too low of voltage or has reversed polarity.

13. If within 2-5 minutes the light turns yellow or flashing yellow this means the charger is charging.

14. Charge the battery until the light turns green (approximately 8-12 hours).

15. When batteries are fully charged, disconnect the power to the chargers and then disconnect the terminal clips and remove the chargers.

16. Reconnect the battery cables 107-132 Lb-in. (12-15 N•m) and check the pack voltage.

17. Power up the vehicle to verify running status.

18. Reassemble the seats and stanchion covers.

19. Keep the vehicle plugged into the onboard charger until delivered to the customer.

DPI smart charger-operating instructions:

The charger uses a sophisticated charging algorithm that continuously tests the charging process from start to finish. Once the charger senses a battery connection, of greater than 3Vdc, it immediately begins its 5-stage charging process as described below in order of which stage the charging process occurs:

PRE-QUALIFICATION TEST - STAGE ONE

Yellow L.E.D Flashing - This first stage tests the battery and determines the condition of your battery. Further charging will be inhibited if the charger determines that the battery's condition is not conducive to receiving a charge. The charger applies a regulated voltage and current charging waveform to the battery while analyzing the charge waveform characteristics with respect to time. If your battery is in fairly good condition, then the duration of this test is about 40 seconds minimum to 3 hours. If your battery has been left in a state of discharge for a long period of time (days to months) then the charger may require 3 hours to determine if the battery will even accept a charge. This length of time is required because the plates have become severely sulfated (similar to iron rusting), and the charger needs time to analyze the battery through the sulfated plates. Sulfating, on the plates, begins to break down as the charge is passed through the battery, but in some cases, the sulfation may have become so great that only time will allow for the removal of the sulfate.

CONSTANT CURRENT CHARGE - STAGE TWO

Yellow L.E.D. Continuous - The charger is charging the battery at full rated output. This stage ends once the battery's terminal voltage reaches the factory preset voltage level of approximately 14.3Vdc.

CONSTANT VOLTAGE CHARGE - STAGE THREE

Yellow L.E.D. Continuous - This stage forces the cells of the battery to become equalized in charge and finishes when the battery has approached near 100% state of charge.

FLOAT CHARGE - STAGE FOUR

Green L.E.D. Continuous - The charger regulates the battery terminal voltage at about 13.25Vdc, which maintains the battery at full state of charge. A regular, periodic check on your charging system, if left unattended and powered, is still recommended (just as you would with any electrical appliance). While in Float Mode, if the charger senses a load that has activated (e.g., pump motor), the charger recycles to the Charging Mode to start charging.

RECYCLE CHARGE - STAGE FIVE

Once, every 84 days, the charge cycle restarts from Stage One.

"FAULT" L.E.D. DISPLAY

Red L.E.D. Flashing - Indicates a "CHARGING FAULT" as a result of one of the following condition:

1. Charger Output Lead connections are reversed.
2. Pre-Qualification Test failed; check battery. If battery is severely discharged, ensure that all battery loads are disconnected until charger has had a chance to recharge battery.
3. Something went wrong with the charging process. Try re-starting the charge process by disconnecting and reconnecting charger from and to A.C. power.
4. If a battery is first connected, with correct polarity, and this L.E.D. is on continuously but no further charge action seems to be taking place, then the battery has a terminal voltage that is too low (less than 3Vdc) for the charger to detect that a connection has been made. Disconnect any battery loads and allow time for the battery to recover. As a result of severe battery discharge, the length of battery recovery time will vary from minutes to hours and days dependent on the length of time that the battery was left in a state of discharge. It is not uncommon to find that the battery may require replacement, because severe discharge is the single largest cause of battery failure.
5. Time-Out error - The charger uses a safety timer to terminate charging if the process required more time to complete. As the batteries age, the charge process takes longer and batteries will eventually not accept a charge.
6. To reset any fault indicator and restart charging process, unplug charger from A.C. Power, for a minimum of 30 seconds. Then plug charger back in. If charger indicates another fault indicator, have battery checked.

BATTERY PACK REMOVAL AND REPLACEMENT

Remove Batteries

1. Take vehicle off charge.
2. Remove front seat bottom cushions and remove seat frames from "H" bracket.
3. Remove front stanchion cover.

NOTE
IT IS NOT NECESSARY TO REMOVE THE "H" BRACKET OR THE PARK BRAKE HANDLE.

4. Check for continuity from battery pack negative and positive to the frame. If there is continuity, do not remove battery terminals until the leak is found.
5. Power down vehicle as described in the Service Manual.
6. Disconnect all battery cables from the threaded terminals.
7. Remove all battery hold-downs.
8. Remove batteries as seen in Figure 3.

Replace Batteries:

NOTE
SEE FIGURE 4 FOR PROPER BATTERY LOCATION AND PLACEMENT.

1. Install battery #2 & #5, polarity must be correct.
2. Install battery #3 & #4, polarity must be correct.
3. Install battery #1 & #6, polarity must be correct.
4. Attach all battery cables 107-132 Lb-in. (12-15 N•m), fuse, & harness connections.
5. Reinstall all battery hold-downs 107-132 Lb-in. (12-15 N•m).

6. Install front stanchion cover.
7. Check battery pack voltage, approximately positive 72V should be present.
8. Put vehicle on a 12-hour charge with the on board charger.

NOTE
ALL BATTERIES INCLUDING NEW BATTERIES, MUST BE WITHIN .2VDC OF EACH OTHER TO BE CONSIDERED BALANCED, IF THEY ARE NOT, REFER TO THE BATTERY PACK BALANCING SECTION OF THIS ARTICLE.

BATTERY TYPE PROGRAMMING

Check that the battery mode (either flooded or gel) corresponds to the battery type installed in the vehicle. If the battery mode is set incorrectly, reset it, charge the vehicle for 12 hours, and retest.

How to reset the battery type:

1. Battery pack voltage must be above 40V.
2. Turn the key in the OFF (black dot) position, press and hold down the Select/Reset button.
3. Turn the key to the D (Drive) position.
4. Release the Select/Reset button.
5. Turn the Key to the R (Reverse) position.
6. Press and release the Select/Reset button to alternate between the flooded and sealed battery modes.
7. Turn the key to the OFF (black dot) position. The gauge will automatically exit the reprogramming mode after 10 seconds or exit immediately by pressing the Select/Reset button.

Gauge ICON Description

Flooded battery = Battery with water ICON.

Maintenance free battery (GEL) = No ICON, gauge defaults to this setting.

ON BOARD CHARGER DESCRIPTION

The battery charger receives 120-volt AC power from an external standard grounded 3-prong outlet and converts it to DC power as required to charge the vehicle battery pack. After properly connecting the vehicle to the receptacle, the charger will initiate a four stage charging process. In the first stage, the battery pack is tested. If the battery pack passes, the charger determines the appropriate charging rate, depending upon the voltage of the battery pack, and charges the battery pack. In the second and third stages, the voltage is regulated, and the charging is completed. The battery pack is maintained at full state of charge in the fourth stage. If the vehicle is left connected to the charger, the charger will automatically reinitiate a new charge cycle every 28 days. The rate at which the battery pack charges will vary, depending on the type of batteries installed. To ensure a fully charged battery pack, the vehicle should be charged continuously and uninterrupted for 12 hours. The instrument cluster battery type ICON must be set for the type of batteries that are installed in the vehicle to prevent excessive charge time or damage to the batteries. The battery charger should only be operated with the supplied GFCI charger cord; it will send a signal to the instrument cluster gauge. The instrument cluster gauge will then display the charging indicator ICON (if the SDS in "ON") and will prevent the vehicle from being driven.

ON BOARD CHARGER OPERATION:

1. If battery pack voltage is above 63V at plug-in, charger will charge at full 10A rate (normal operation).
2. If battery pack voltage is below 63V at plug-in (deep-discharge condition), charger will charge at 2A for 3 hours.

At completion of Step 2 at charge of 2A for 3 hours, the charger will check battery pack voltage and determine next charging sequence.

   a. If battery pack voltage is below 50V, charger will shut down (error condition).
   b. If battery pack voltage is between 50V and 63V, charger will charge at 4A for 2 more hours.
   c. If battery pack voltage is greater than 63V, charger will begin a normal charge cycle at 10A.

At completion of Step 4b at charge of 4A for 2 hours, the charger will check battery pack voltage and determine next sequence.

- If voltage is below 63V, charger will shut down (error condition)
- If voltage is greater than 63V, charger will begin a normal charge cycle at 10A

NOTE

IF THE CHARGER SHUTS DOWN FOR AN ERROR, IT IS POSSIBLE TO UNPLUG AND REPLUG THE CHARGER TO RESET THE CHARGE CYCLE.

WARNING

DO NOT CHARGE THE BATTERIES WITH THE WEATHER ENCLOSURE CLOSED OR THE VEHICLE COVER IN PLACE. A BUILD UP OF HYDROGEN GAS CAN RESULT WHICH CAN EXPLODE. THE CHARGING AREA SHOULD BE WELL VENTILATED.

VEHICLE RANGE CONCERNS

Check each individual battery and make sure they are all within .2V of each other. If they are not within .2V, check each battery with the Micro 490 by connecting to the lead doughnut, if one or more are bad replace with new batteries. Balance all batteries by individually charging each of them with the DPI smart charger; reference the battery pack balancing section for instruction.

Factors Affecting Mileage Range Of The Vehicle:

The battery pack will decrease in capacity over time, resulting in decreased mileage range. This is a characteristic of these batteries. Batteries should not be replaced simply because the customer achieves less range than when the vehicle was new. Some judgment should be exercised when evaluating range. Factors affecting mileage range on electric vehicles include:

- **Type of tire -** Vehicles equipped with turf tires will have less range than vehicles equipped with street tires, due to greater frictional drag from the wider turf tire
- **Age of battery pack -** Battery capacity decreases as batteries age
- **Weak or failed individual battery -** A module that is .2V or more from the other battery modules in the pack or is checked "bad" by the Micro 490
- **Temperature -** Battery capacity decreases as temperature drops
- **Driving style -** Heavy acceleration demands more power from the battery pack than gradual acceleration
- **Terrain -** Climbing steep grades may deplete the battery pack
- **Pavement vs. Off-Road -** Vehicles driven off road will have less range
- **Lack of free wheel movement -** Check vehicle for any evidence of brake drag, by putting the vehicle on a hoist and checking wheels for free rotation
- **Other Electrical Loads -** Lights, Heater/Defogger, Powerpoint accessories, etc. (note that all Powerpoint accessories should be disconnected when the vehicle is charging).

Before recommending replacement of the entire pack to a customer simply because pack capacity has decreased due to age, discuss the situation with the customer. If the customer is in the second or third year of vehicle warranty, when battery coverage is pro-rated, the customer may choose to accept some reduced range and delay pack replacement until absolutely necessary.

Battery Capacity:

Mileage range of the neighbor is determined by customer driving cycle and battery capacity, and is not directly related to voltage. A neighbor battery may test above 12 volts yet still have poor capacity. Capacity is analogous to the size of the fuel tank in an internal combustion vehicle. Battery capacity is affected by temperature (see Figure 5) and changes as batteries age. It is also affected by the rate of discharge. The faster the batteries are discharged, the less battery capacity is available (and the faster the batteries will be recharged). The more slowly the batteries are discharged, the more pack capacity is used, and the longer it will take to recharge the batteries. Battery capacity increases for about the first 75 to 150 cycles of a flooded battery, and the first 25 to 75 cycles of a gel battery. After the capacity peak is reached, the battery pack stabilizes, and then capacity begins to decline. Battery maintenance and charging habits directly impact peak capacity and the point in time when peak capacity is reached. Proper maintenance and regular charging will increase time to peak as well as peak capacity. After battery capacity has stopped increasing, which is estimated to take approximately 90 days. The manufacturer's rated capacity of the flooded battery is 130 amp-hours, and the gel battery is 97 amp-hours. The state of charge (the amount of energy available from the battery at any particular time) of the individual modules within the pack must be similar or balanced for the pack to function correctly.

NOTE

IT IS NORMAL THAT, OVER TIME, THE BATTERY PACK CAPACITY WILL DECREASE RESULTING IN DECREASED MILEAGE RANGE. WARRANTY REPLACEMENT OF A BATTERY PACK DOES NOT COVER A BATTERY PACK THAT HAS BEEN CYCLED THROUGH A NORMAL LIFE EXPECTANCY. REFER TO ADDITIONAL INFORMATION PROVIDED WHEN ASSESSING IF BATTERIES SHOULD BE REPLACED UNDER WARRANTY.

Testing Mileage Range:

The Th!nk Neighbor achieved 31 miles on the Federal Urban Driving Standard test. This drive cycle is complex and probably cannot be reproduced in a dealership environment. However, the following guidelines will help establish a driving course to determine if a customer is experiencing poor range, or if the battery pack is performing as expected.

- Choose driving surfaces that are paved, and relatively flat
- Some moderate hills are acceptable, as long as they are not more than 1/2 mile and less than 5% grade
- Try to find a route that has five or less stops and starts (i.e. stoplights)
- Try to spend at least 55% of the drive cycle time at 70% max speed, or around 18 mph
- Drive vehicle from a full charge (12-18 hr charge cycle), and until one bar is showing on the gauge.

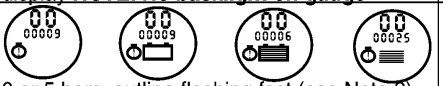
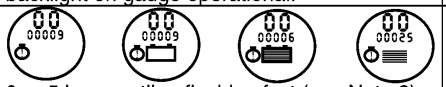
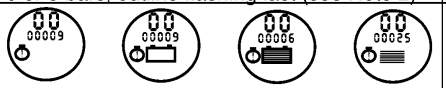
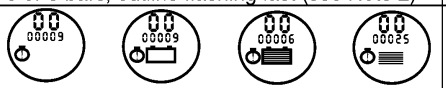
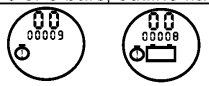
NOTE

VEHICLE RANGE DOES VARY FROM VEHICLE TO VEHICLE, IT IS CONSIDERED ACCEPTABLE TO ACHIEVE 20 MILES OR GREATER ON A FULL DRIVE CYCLE, USING THE ABOVE DRIVE CYCLE CONDITIONS.

OTHER APPLICABLE ARTICLES: 02-25-9
WARRANTY STATUS: INFORMATION ONLY
OASIS CODES: 203000, 203100, 203200, 204000, 204100, 206000, 601300, 602300, 603300, 607000, 607500, 610700, 611000, 614000, 622000

Figure 1 - Article 03-8-6

NEIGHBOR FUNCTIONAL CHART

Battery Pack Voltage	Gauge	Charger (see Note 1)	Controller	DC/DC Converter
0V to 20V	Non-functional vehicle, AC plug icon will not display **NOTE: No backlight on gauge**	Charger hums, will not charge	Contactor will not close	No function
20V to 40V	 0 or 5 bars, outline flashing fast (see Note 2) Clicking may be heard from gauge backlight on gauge operational.	Charger hums, vehicle charges at 2A rate, battery pack voltage will rise	Contactor will not close	No function
40V to 50V	 0 or 5 bars, outline flashing fast (see Note 2)	Charger hums, vehicle charges at 2A rate, battery pack voltage will rise	Contactor will not close	12V DC/DC converter output low, dim lights
50V to 63V	 0 or 5 bars, outline flashing fast (see Note 2)	Charger hums, vehicle charges at 2A rate, battery pack voltage will rise	Contactor will not close	12V DC/DC converter operational
63V to 68V	 0 or 5 bars, outline flashing fast (see Note 2)	Charger hums, vehicle charges at 10A rate, battery pack voltage will rise	Contactor will not close	12V DC/DC converter operational
68.3V to 69.8V	 0 or 5 bars, outline flashing fast (see Note 2)	Charger hums, vehicle charges at 10A rate, battery pack voltage will rise	Vehicle will drive	12V DC/DC converter operational
69.8V to 70.6V	 1 bar, outline flashing slow	Charger hums, vehicle charges at 10A rate, battery pack voltage will rise	Vehicle will drive	12V DC/DC converter operational
70.6V to 72.0V	 2 bars, outline solid	Charger hums, vehicle charges at 10A rate, battery pack voltage will rise	Vehicle will drive	12V DC/DC converter operational
72.0V to 73.4V	 3 bars, outline solid	Charger hums, vehicle charges at 10A rate, battery pack voltage will rise	Vehicle will drive	12V DC/DC converter operational
73.4V to 74.9V	 4 bars, outline solid	Charger hums, vehicle charges at 10A rate, battery pack voltage will rise	Vehicle will drive	12V DC/DC converter operational
74.9V to 80V	 5 bars, outline solid	Charger hums, vehicle charges at 10A rate, battery pack voltage will rise	Vehicle will drive	12V DC/DC converter operational
80.1V to 95.0V	 5 bars, outline solid	Charger hums, vehicle charge is near competition, current will be 10A or less	Contactor will not close. These voltages only seen while on charge or while going downhill, with regenerative braking activated and full state of charge	12V DC/DC converter operational

TB-6665-A

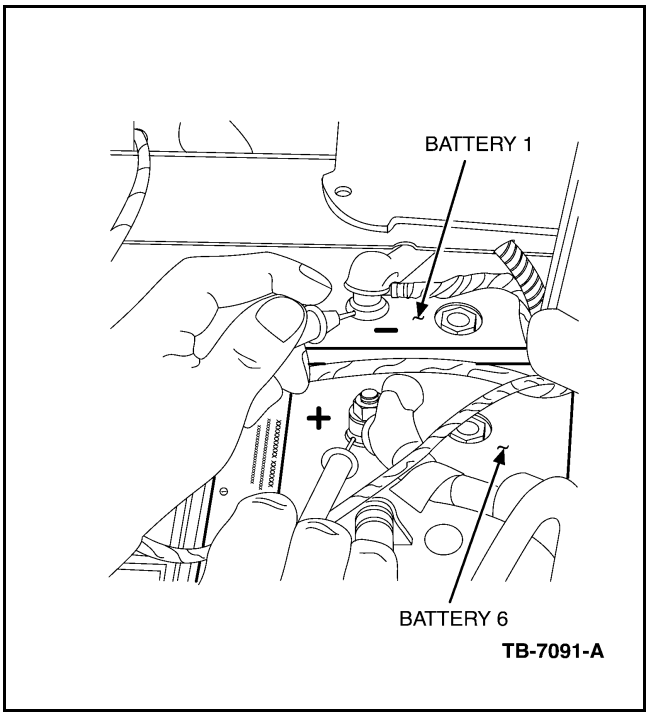


Figure 2 - Article 03-8-6

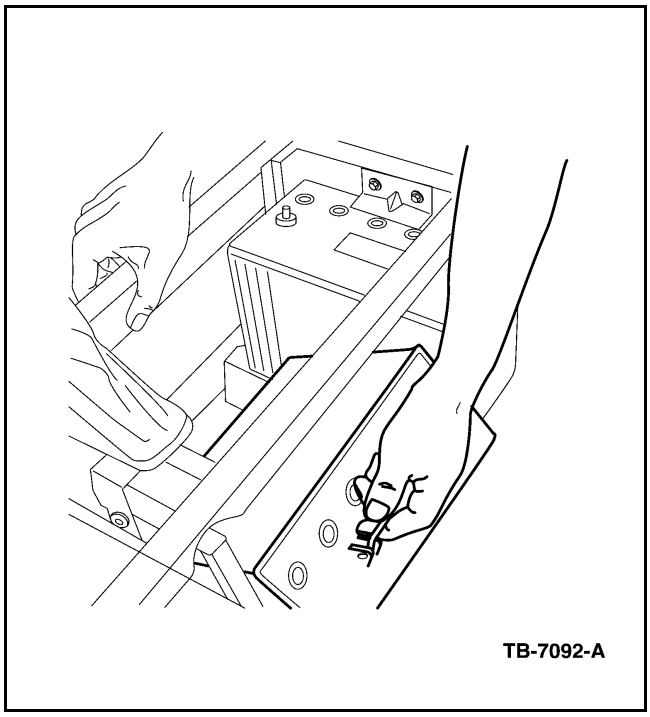


Figure 3 - Article 03-8-6

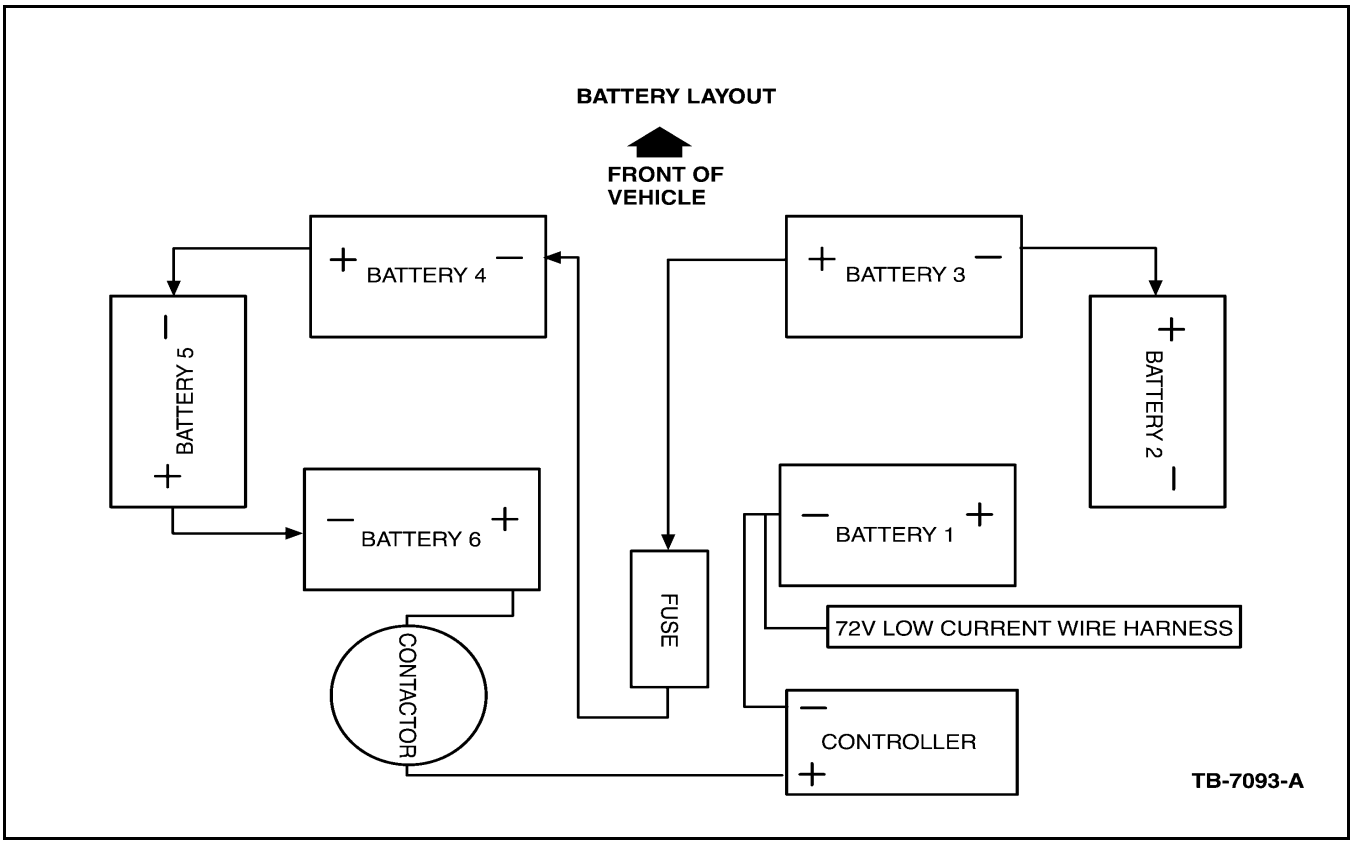


Figure 4 - Article 03-8-6

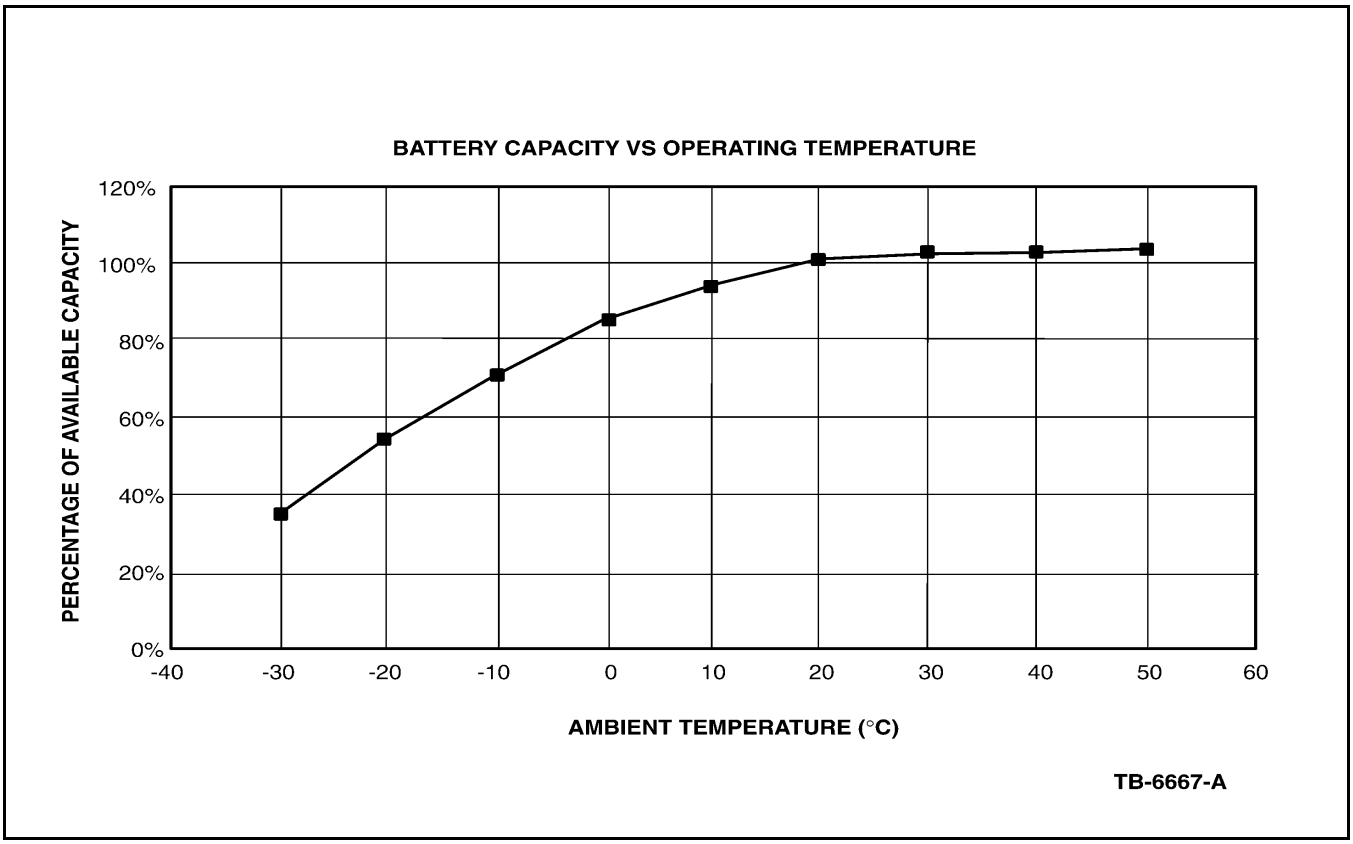


Figure 5 - Article 03-8-6

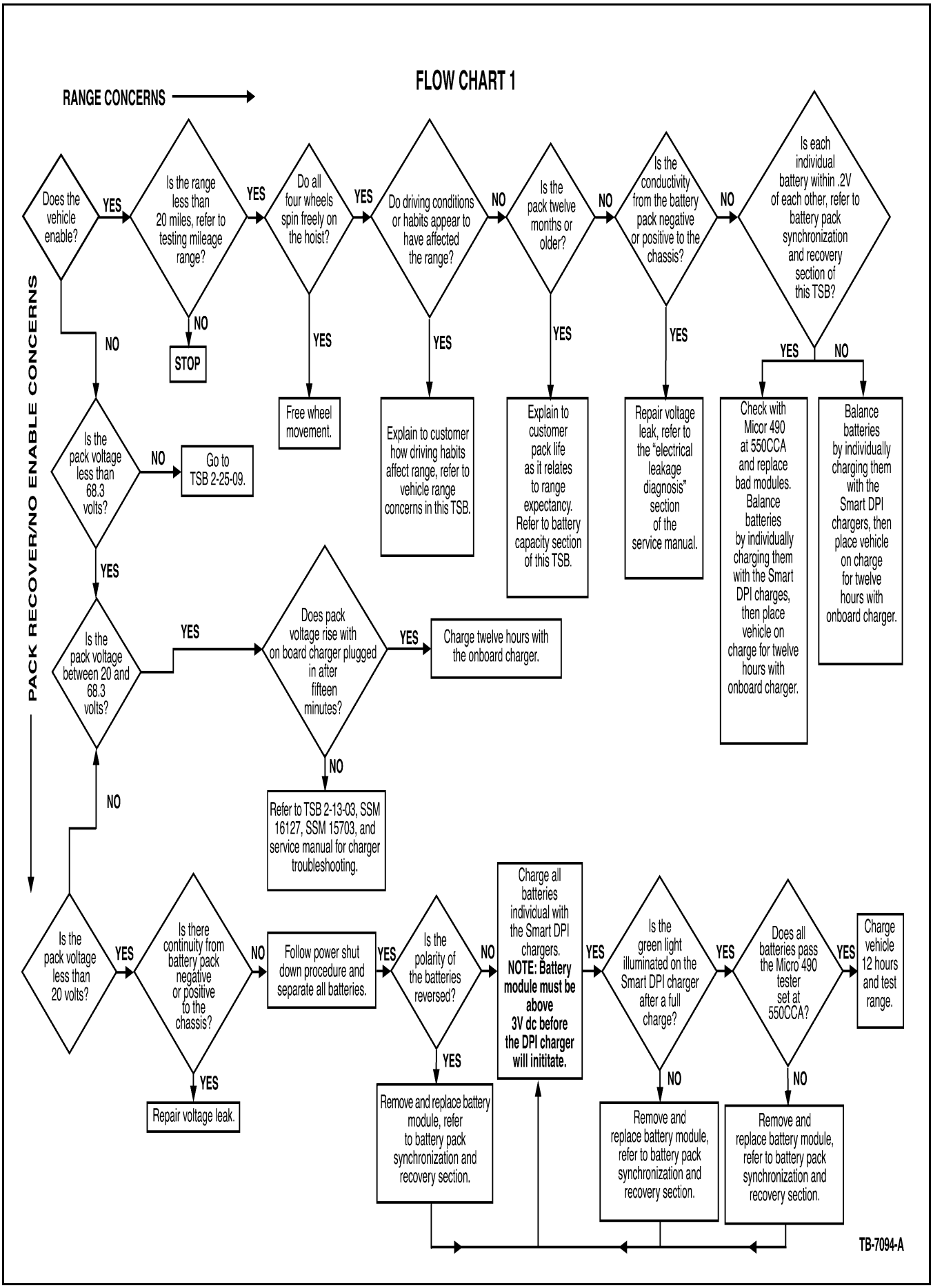


Figure 6 - Article 03-8-6